

Zephyr: "An Internet-based Process to Streamline Engineering"

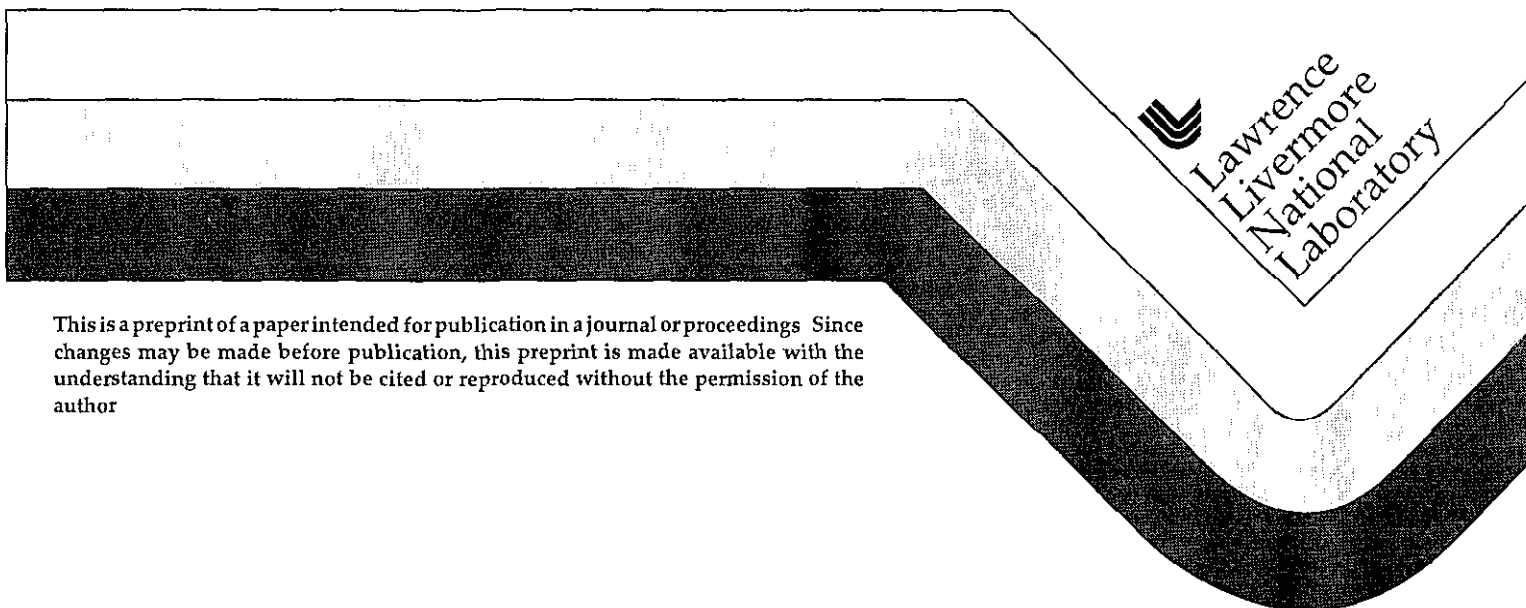
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This paper was prepared for submittal to the
CALS Expo International & 21st Century Commerce 1998
Global Business Solutions for the New Millennium

Long Beach, CA
October 26-29, 1998
and

AACE Association for the Advancement of Computing in Education WebNet98
Orlando, FL
September 22, 1998

July 1998



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Zephyr: "An Internet-based Process to Streamline Engineering"

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Abstract: *Lawrence Livermore National Laboratory (LLNL) is implementing an Internet-based process pilot called "Zephyr" to streamline engineering and commerce using the internet. Major benefits have accrued by using Zephyr in facilitating industrial collaboration, speeding the engineering development cycle, reducing procurement time, and lowering overall costs. Programs at LLNL are potentializing the efficiencies introduced since implementing Zephyr. Zephyr's pilot functionality is undergoing full integration with Business Systems, Finance, and Vendors to support major programs at the Laboratory.*

Introduction: The Pilot Project

Zephyr is a paperless, distributed web-workflow approach that streamlines the procurement of fabricated parts and assemblies. It electronically links all the steps in the engineering and procurement process including concept, collaborative design, approval, solicitation, supplier selection, award, technical data transfer, shipment, delivery, receipt, invoicing, and payment.

The actual development of Zephyr received over four years of funding through the Department of Energy (DOE).

However, its success draws on contributions from a decade of work funded by the Department of Defense (DoD).

Projects that have contributed to its success include Lawrence Berkeley National Laboratory's Web-based computer-aided design system, the DoD's Air Force-administered Computer-Aided Acquisition and Logistics Support Program (CALS) (ref 1), the Air Force's Government Acquisition Through Electronic Commerce (GATEC) System, (ref 2), and the Department of Commerce (DOC) Technology Reinvestment Program's CommerceNet.

Zephyr was developed by LLNL's Engineering Directorate in partnership with the Laboratory's Administrative Information Systems, Procurement, and Computation departments. Zephyr can move "design concepts" 60-90% faster than previous paper-based approaches from engineering design release, through contract award, to product delivery and payment. Zephyr links people in Laboratory programs, engineering, and procurement to pre-qualified small and medium enterprises (SME's) across the nation or internationally in a practical, simple, secure way.

Procurements of fabricated parts and assemblies are now done up to 90% faster, from initial request to delivery

All the process steps are conducted via a World Wide Web browser (Netscape or Internet Explorer) and e-mail. These steps are secure, that is firewalled, encrypted, password-protected and provide information on a need to know basis

Zephyr's web-based workflow process moves projects from the traditional paperwork path toward interoperable systems which share a common browser technology. The Lab's programs benefit from a compressed time-frame for engineering deliverables by assuring valid designs, minimizing schedule impact, and reaching project goals sooner

Zephyr was recently the subject of two case studies by the UC Berkeley Fisher Center for Management and Information Technology, Walter A. Haas School of Business, (ref 12-13), recognized by the Department of Defense US Navy as a "Best Manufacturing Practice" (Winter 1997), by the Department of Energy as a "Best Practice for Procurement and Material" (Fall 1996), A. Coopers & Lybrand

Consulting, Report (August 1996) and through a CALS-CommerceNet pilot has received G7 endorsement as a candidate for world-wide trade and commerce (Fall 1995). Our homepage can be found at <http://zephyr.llnl.gov>

Description

Zephyr began as a pilot concept system called CERPS (Concurrent Engineering Rapid Prototyping System). CERPS (ref 3), networked LLNL's engineering and business systems linking them to multiple commercial and government partners to speed all aspects of the engineering development cycle independent of geographic location (fig 1)

Zephyr (ref 4), improved upon CERPS by integrating engineering processes related to solicitation, collaboration, design, procurement, payment, fabrication, testing, and evaluation into interoperable systems. Interoperable processes are both precursive and critical to seeking industrial partnerships, developing engineering concepts, securing goods or services, and assuring product quality

Model: Zephyr Pilot System

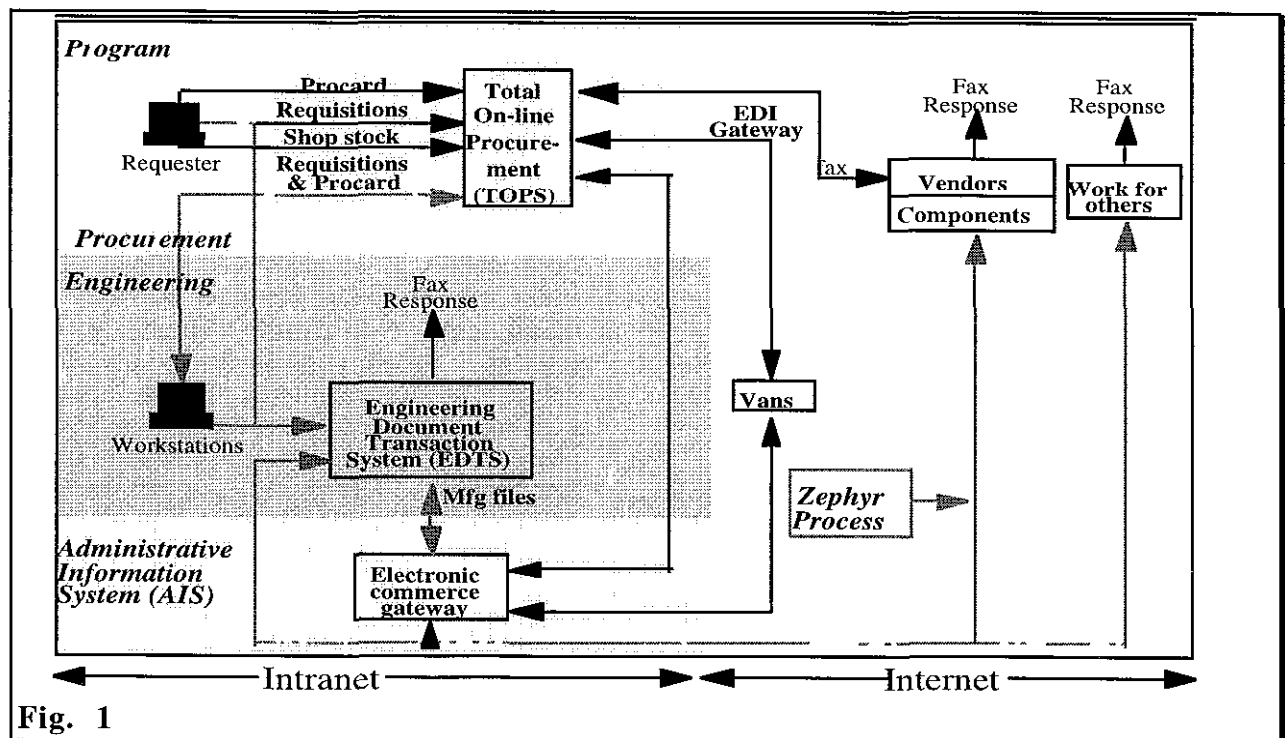


Fig. 1

With centralized, sharable data sources, and Zephyr's web-workflow process (fig 2), people in LLNL's programmatic organizations, engineering, procurement, finance, and development partners are assured of accurate and timely information

Interoperable systems integration (fig 3) (ref 5), plus web-workflow facilitate rapid procurement and delivery cycles while meeting all DOE purchasing requirements at the Laboratory

Model: Zephyr Web-based Workflow

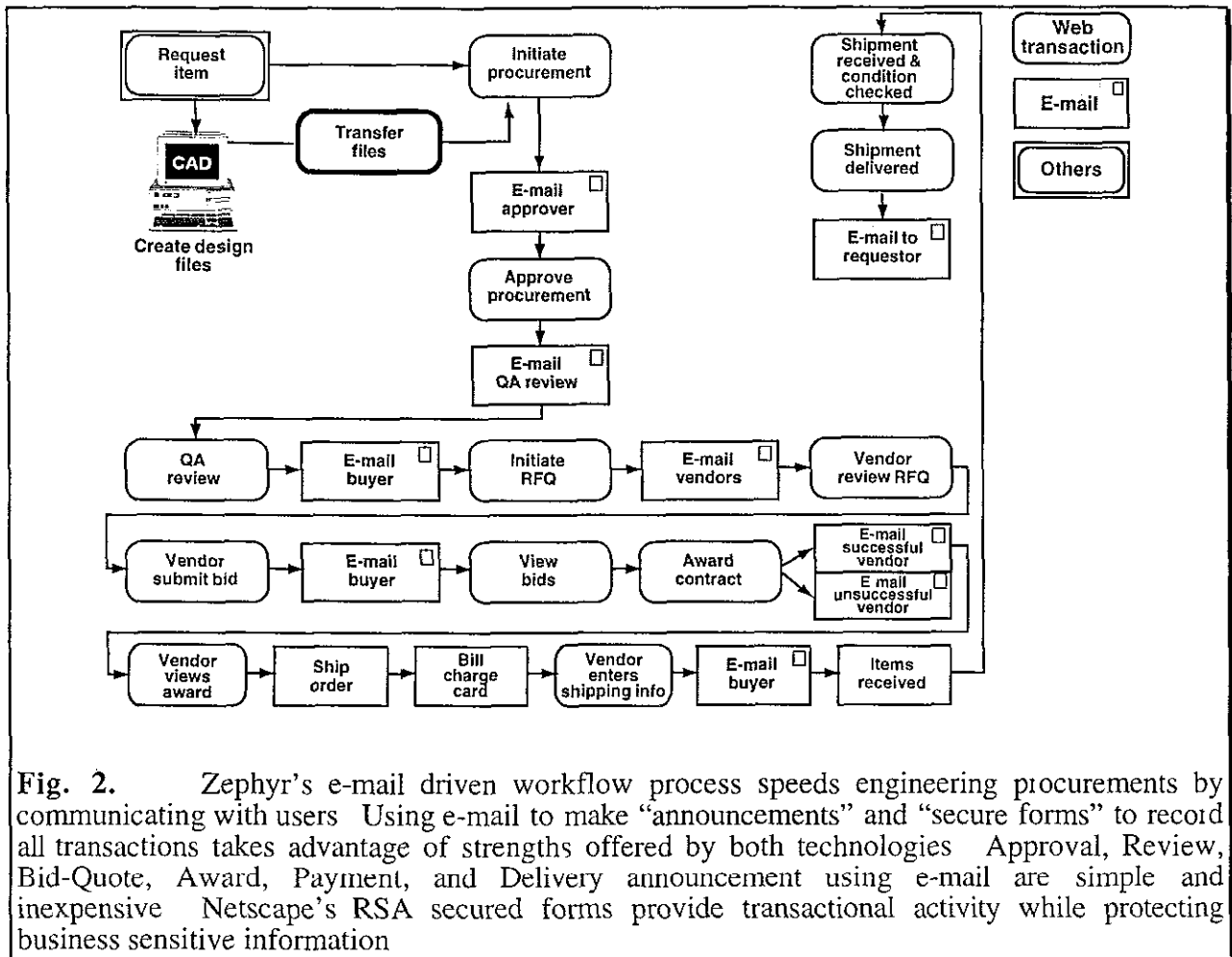


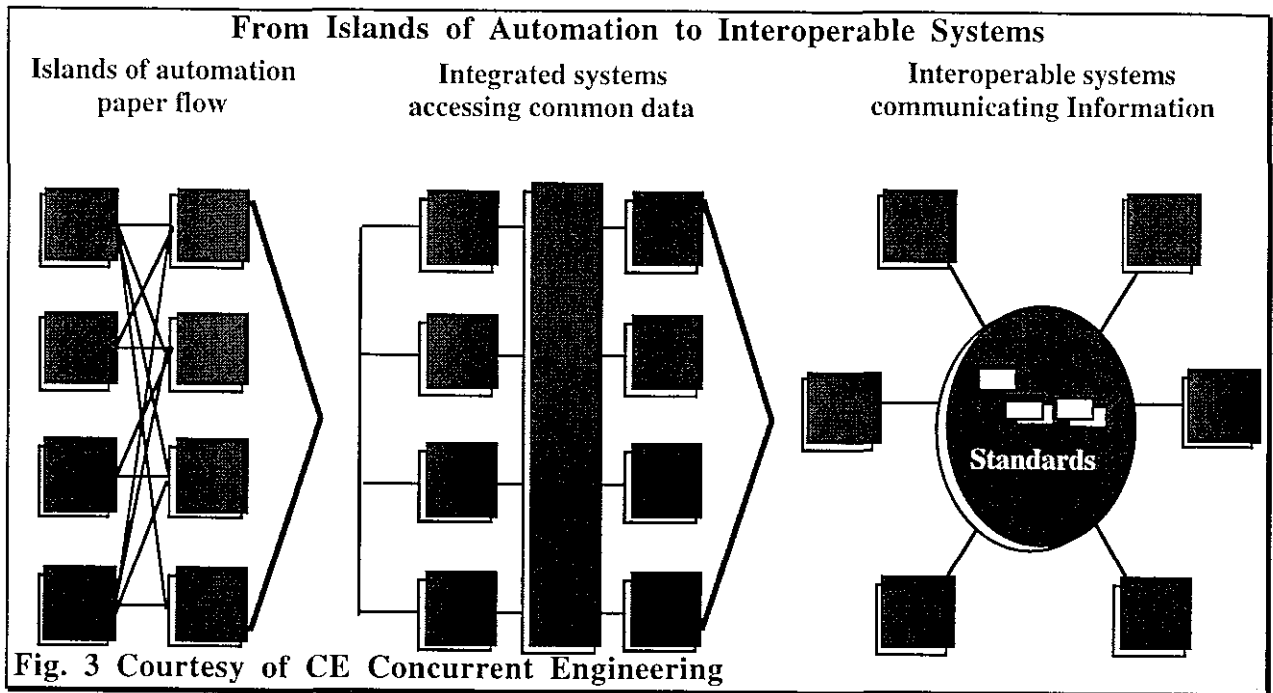
Fig. 2. Zephyr's e-mail driven workflow process speeds engineering procurements by communicating with users. Using e-mail to make "announcements" and "secure forms" to record all transactions takes advantage of strengths offered by both technologies. Approval, Review, Bid-Quote, Award, Payment, and Delivery announcement using e-mail are simple and inexpensive. Netscape's RSA secured forms provide transactional activity while protecting business sensitive information.

Security

Zephyr's daily operations and computer security are dependent upon administrative and technical systems expertise within LLNL's Administrative Information Systems (AIS). AIS is responsible for LLNL's Business Systems and as a course of normal operations protects critical business sensitive and proprietary information to assure the Laboratory's mission.

Operational security risk must be well articulated before responsible business activity can commence. Risk assessment, by trusted independent third parties, assures operators and users of the integrity ascribed to a particular commerce service. A graded approach to computer security, matching security expense with security risk, allows affordable operations in known risk environments.

Model: Interoperable Secure Hub



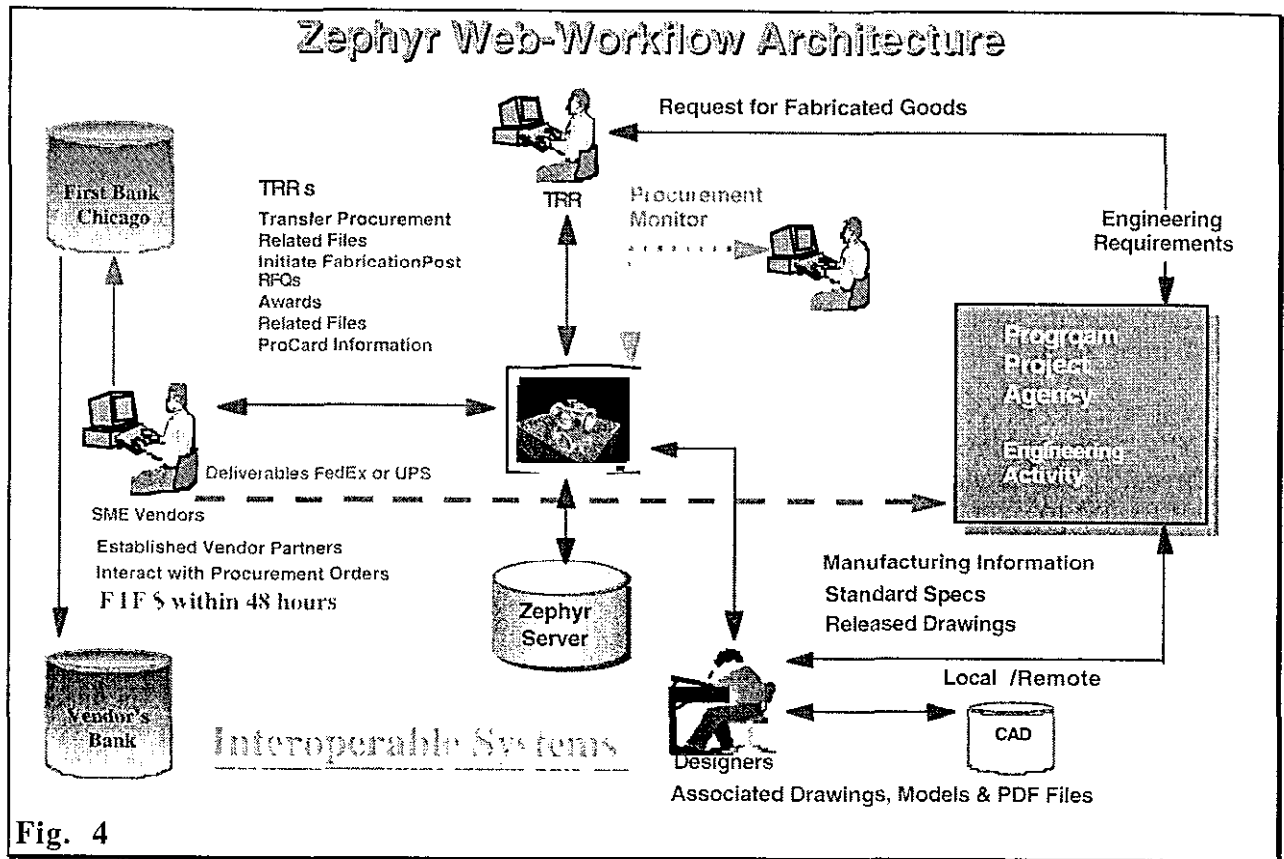
Firewalls, intrusion monitoring, user name-password, encryption, and "need to know" access to information are common technical elements of a secure operation. However, in and of themselves, "technical solutions" may foster but do not assure website security.

The combination of robust Administrative Security Plans coupled with properly applied "technical solutions" (solutions which are an integral part of daily operations) provide

consistent and well understood limits to computer security risk when properly maintained.

Host-client network architectures, like Zephyr, require vigorous risk assessment prior to establishing operations and constant review as new technologies emerge through the course of on-going operations (fig 4).

Model: Interoperable Systems A Secure Hub



Zephyr does not use technologies such as conventional file transfer protocol (ftp), X-Windows, and anonymous log-in. Using these protocols, in unprotected environments like the Internet, are an invitation to computer security intrusions and misuse.

Developing a secure host, in a client-host architecture, is the keystone for web security. Browser technology, like Netscape's Commerce Server, and protocol restrictions are important elements in reducing host-client risk associated with conventional file transfer protocols.

Solicitation

Solicitation involving potential contractors is an initial step in many engineering projects. The solicitation process defines legal, technical, and environmental requirements necessary to accomplish project goals while

developing a proposal leading to contract award.

Communicating information such as terms and conditions, contract iteration, specifications which contain technical information including engineering reports, and "blue prints" are common. Traditional processes communicate and protect information but are bound by non-value added delays inherent in paper printing, mailing, reviewing, and iteration during the solicitation phase of a project.

Secure web servers eliminate non-value added processes while protecting proprietary contractor information. Sharing project proposal specifications with selected contractors in a simple "download" format like Adobe Acrobat's portable document format (pdf) can expedite the solicitation phase of engineering projects. More importantly, electronic solicitation establishes

file exchange techniques for project collaboration as a business practice once a contract is awarded

In a recent solicitation, LLNL's National Ignition Facility (NIF) Program awarded a contract for NIF's Target Chamber Assembly by simply posting technical specifications to selected contractors using the Internet. Such postings allow potential Contractors consistent "on-demand" information, regarding specifications and changes, while maintaining a single informational source

At DOE's Oak Ridge National Laboratory (ORNL) the Procurement Division implemented a Solicitation Management Server (SMS) to expedite solicitations using the Internet-World Wide Web. In pilot demonstrations involving 300 solicitations, ORNL reports a 20-80% reduction in cycle time with the procurement functions that SMS facilitates. Los Alamos National Laboratory (LANL), a user of SMS, estimates as much as 50% cost savings over similar paper processes (ref 6)

SMS enables buyers to assemble a solicitation from solicitation specific templates and existing standard files. The solicitation-specific files are easily uploaded while the standard files are only linked in at the time the solicitation is viewed by the buyer to ensure current information

SMS provides a means for the buyer to submit the solicitation for approval and/or review to selected persons. Once vendors are selected the buyer can post a solicitation to the pre-selected vendors. Posting the solicitation notifies vendors by e-mail and grants the vendors access to view the solicitation's homepage on the Web. The homepage viewed by a vendor is again dynamically generated ensuring current data

Vendors are able to ask questions and view answered questions from the homepage. Access to the homepage is limited to only selected vendors and buyers. The buyer can monitor the progress of the solicitation throughout the entire process

SMS is easy to use which accounts for its rapid acceptance in a Procurement department over 100 strong. SMS has demonstrated the creation of solicitations in minutes, live, over telephone lines at national conferences. It requires no formal training for buyers, and after being shown basic steps, even non-computer users are comfortable using it. Most importantly SMS saves projects time and money

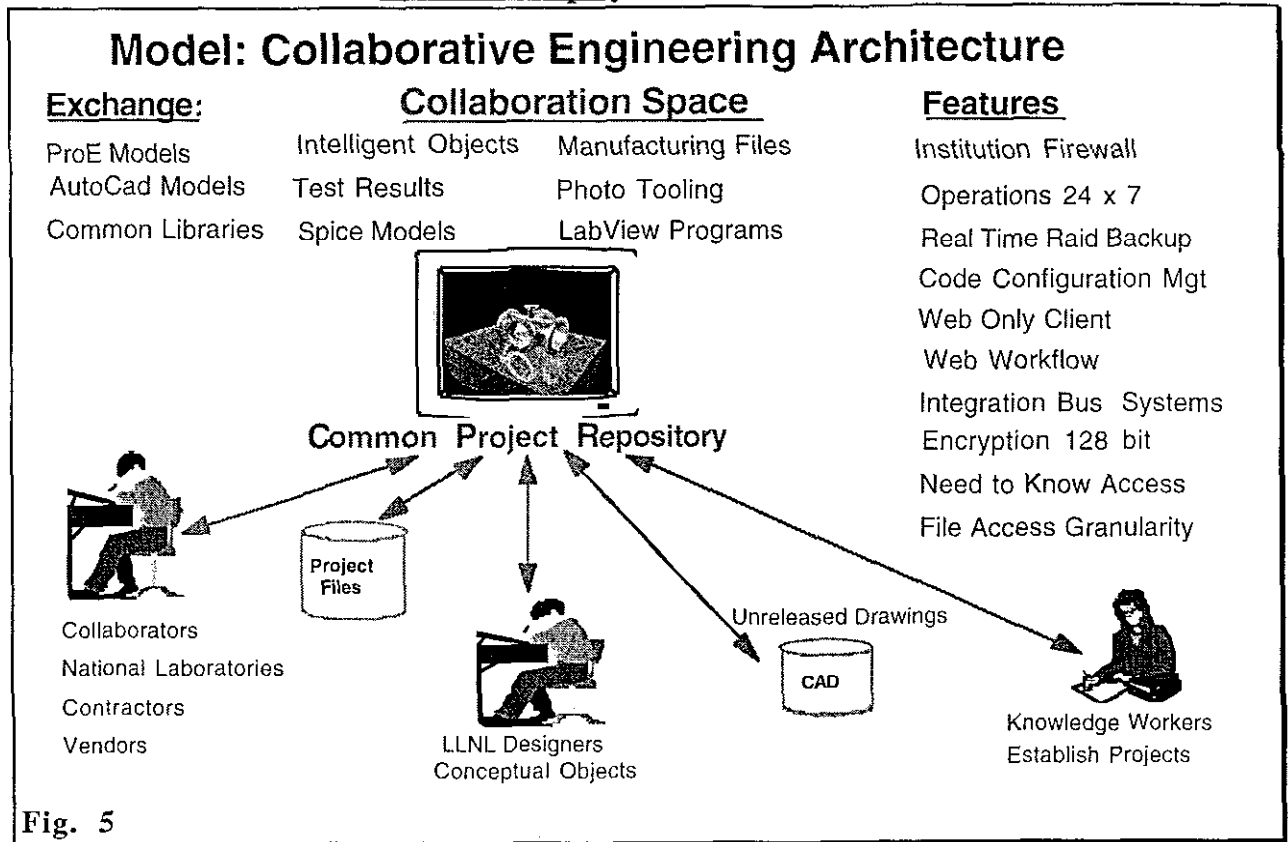
Collaboration

Collaboration among engineering teams is a critical element in meeting project deliverables, schedules, and minimizing costs. Small teams typically located "on-site" at engineering projects require accurate and timely information for changes in specifications, drawings, CAD models, tooling files, computer software, and many other "critical path" items (fig 5)

Traditionally, teams gathered at engineering reviews exchanged information across the table by marking up drawings, project schedules, and specifications. The communications were both immediate and interpersonal. Engineering disciplines have performed tasks effectively this way for hundreds of years. It worked because all the information, technology, and decision makers were "at hand". However, when information, technology, and decision makers were not "at hand" schedules protracted, cost increased, and re-work dominated the process. Many times projects became intractable and simply failed.

Today engineering information, industrial technology, and decision makers are not always "at hand". In fact, these critical engineering elements tend to be globally distributed.

Model: Zephyr Collaboration



It is common, to design a product in one country, produce the product in another, and deliver product on a global basis. Automobiles, aircraft, and many consumer goods are excellent examples. Engineering and commerce on the Internet speeds the engineering process by "virtually" providing critical engineering elements in forms intended for immediate use (ref 7).

Zephyr-based collaboration, known as "zephyr_partners", is important to several nationally and internationally distributed engineering teams. However, it is critical to LLNL's Advanced Radiation Machine

(ARM) Project. ARM is developing a new generation of linear induction accelerators. It shares engineering information between LLNL, Bechtel's North Las Vegas, Nevada Facility, and Allied Signal's Kansas City Plant in Kansas City, Missouri.

Vital paperless engineering information such as project schedules, CAD drawings, base-line performance-design, common design libraries, object-oriented design tools, 3D Models, integrated circuit design specifications and testing data are exchanged in seconds (fig 6).

Example: Paperless Engineering Information

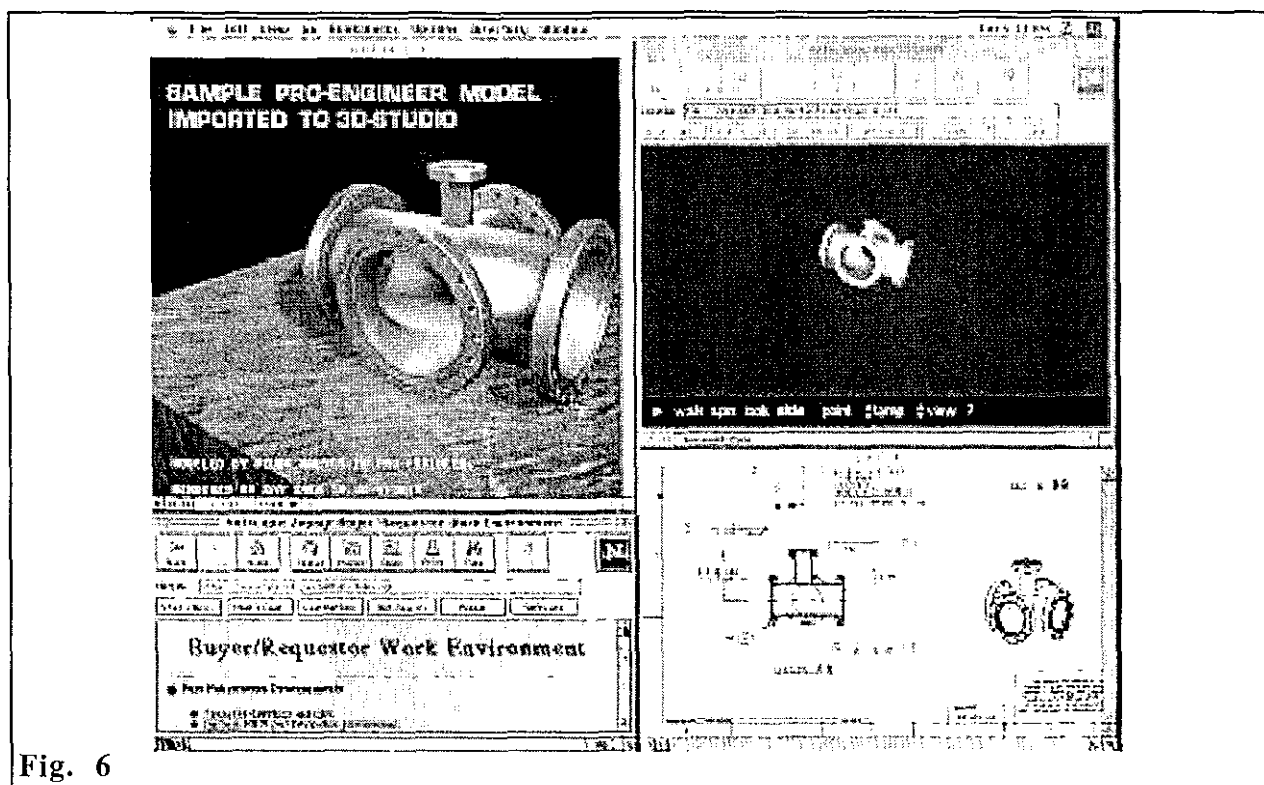


Fig. 6

Engineering teams share current information and knowledge using interoperable systems. Decision makers collaborate and concur within minutes and hours instead of weeks or months. Projects are better able to avoid unnecessary risk, stay within budget, and meet scheduled delivery dates.

ARM's Project Engineer stated that "without such a capability this project could not be accomplished within the allocated project time and budget." Similar stories of "collaborative value" have been documented between LLNL, other DOE National Laboratories, and Industrial Partners (national and international) in the development of high-performance optics, state of the art laser amplifiers, and massive power conditioning systems.

Procurement

Once engineering teams release a design for manufacturing, engineering services which meet specific design requirements must be provided. Zephyr's procurement workflow

process is initiated upon a user request to procure engineering goods or services. Soon after engineering design release, a buyer prepares an electronic request for quotation (RFQ) package.

Next, Zephyr's procurement web-workflow process e-mails a vendor announcement indicating the presence of the RFQ in a secure section of the Zephyr World Wide Web "home page." After the announcement, all solicitations, quotations, awards, technical data exchanges (manufacturing files, drawings, and specifications), payments, delivery tracking, and record-keeping are provided for by Zephyr's workflow process. At all transactional levels, the benefits of compressed cycle time, ease of use, and secure business information are realized (ref 8).

Payment

In keeping with Zephyr's mission to streamline the engineering procurement cycle, we have employed the use of LLNL's

corporate purchasing card (Procard) as our primary payment mechanism to round out the procurement cycle

Procard — a Mastercard purchasing card provided to LLNL by First National Bank of Chicago — solidifies the Zephyr business partnership by expediting payment (in most cases electronic funds transfer) to the business's bank, usually within 48 hours from product shipment

First National Bank of Chicago's Mastercard was chosen because of its world-wide acceptance, ease of payment processing, and enhanced point-of-sale reporting capabilities

Manufacturers are interested in developing new ways of providing engineering goods and services to LLNL. Procard prompt payment and potential new business with Zephyr's competitive edge are clearly attractive manufacturer benefits

In a series of pilot procurements, Zephyr's procurement officer purchased non-standard optical components using Zephyr's paperless bid-quote process and Procard. The bid package, request for quote, and award-process cycle took less than 5 days as opposed to longer cycle times associated with the traditional paper-based processes

Because of Procard's prompt payment, our procurement officer negotiated "same as cash" discounts amounting to \$120,000 in just two months. Zephyr's workflow process allows rapid accrual of such savings

Zephyr's primary payment mechanism is First National Bank of Chicago's Procard. However, existing purchase and blanket orders are well understood payment mechanisms which are easily accommodated by Zephyr's web-based processes.

Implementation

One of Zephyr's key milestones was a project review at the first meeting of the Lab's Engineering and Commerce on the Internet (ECI) Working Group. This working group consisted of representatives from

Engineering, Procurement, Administrative Information Systems, Computation, and Technical Information Systems

The ECI Working Group reached an agreement to promote Internet-based approaches to lower LLNL's cost of doing business. Such corporate-wide "working group" agreements are critical to implementing institutional cultural change

However, technology alone will not assure complex engineering-business cycle reductions in time or cost. Administrative change must precede and complement "technical" implementation. Without such congruity, many excellent technical solutions fail to reach potential and eventually default to the "time honored" techniques of avoidance or misuse (ref 9)

Zephyr has been in constant operation since its inception as a pilot project in March 1995, providing immediate access to a wide variety of organizations in many locations across the country

Metrics

In 1995-96 Engineering dramatically saved time in a series of prototypical manufacturing procurements. For example, Internet-based procurement of an assembly fixture in 5.5 days was 90% faster than traditional (paper-based) cycle times

In other tests, prototype printed circuit boards were purchased in less than 2 days, again 90% faster cycle times

Such transactions represent procurements of less than \$5,000 per order but are 80% of the volume of custom manufactured items in Electronics Engineering (ref. 10)

In 1997-98, the metrics established in prior years remains valid. Engineering's use of Zephyr in LLNL's Electronics Manufacturing Group has allowed wide-access to manufacturing procurement through out the Laboratory while providing on-line access to industrial partners and vendors using the Internet-WWW

In 1997, "zephyr_partners" was initiated thereby enabling collaborative on-line engineering teams to share current information and expert knowledge using interoperable systems prior to procurement. Decision makers now collaborate and decide upon questions within hours instead of weeks or months. Projects using such collaborative techniques avoid unnecessary design risk and adverse budget impacts while meeting schedule delivery dates.

In 1998, we conducted our third Industrial Partnering - Procard Vendor Outreach Program.

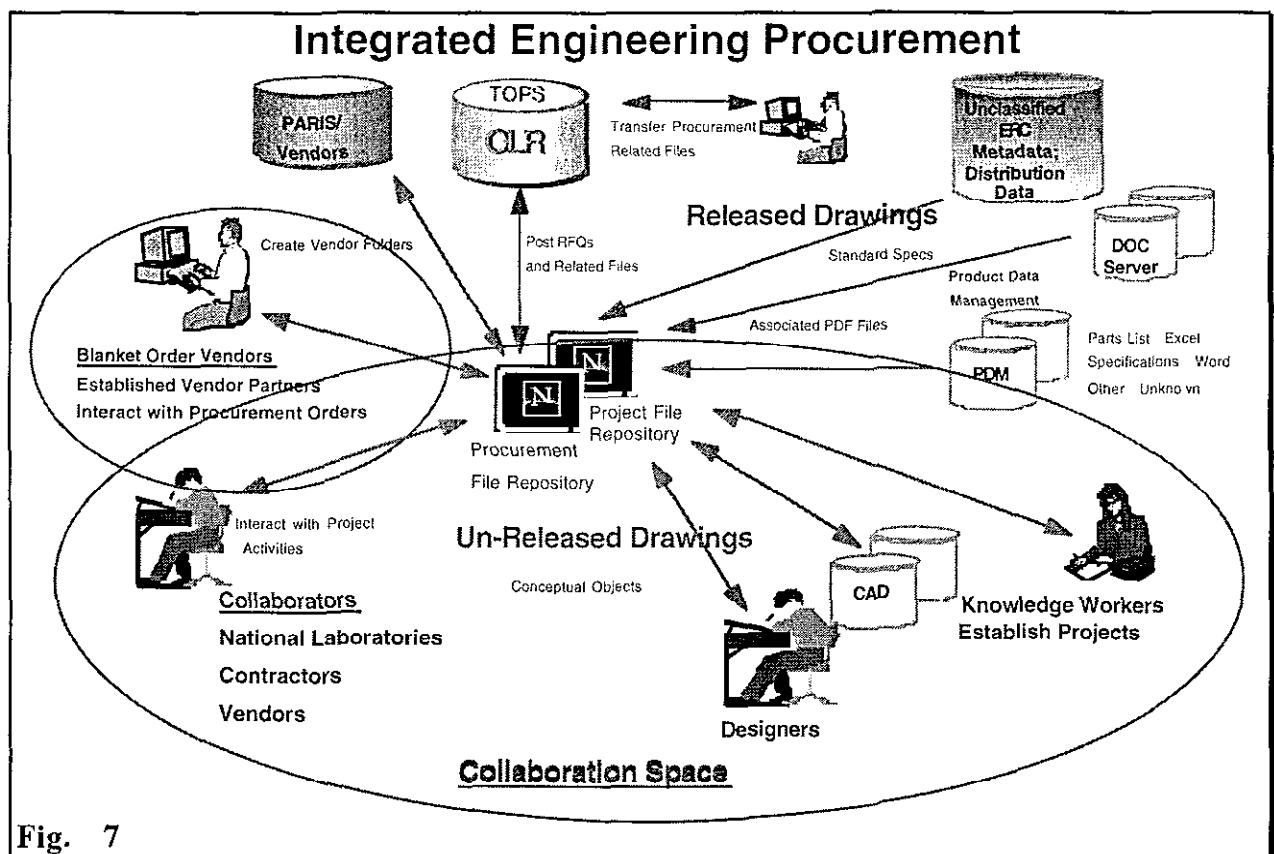
Furthering our goal to develop meaningful partnering relationships with our vendors, the Laboratory initiated an annual Procard Symposium and Trade Show event.

Procard vendors are invited to attend a 2-3 hour training presentation in a business

meeting forum to learn about the evolution and changes within the Laboratory's new Procard low-value purchasing model. As incentive to attend this training session, participating vendors are also allowed to host a table in a trade show environment to demonstrate new product offerings and distribute catalogs to LLNL customers.

This event is extremely well attended and is currently receiving national recognition as one of the most innovative Vendor Outreach Programs throughout the Federal complex. Approximately 250 vendors participate with over 2500 Laboratory personnel visiting the trade show. As added incentive, cardholders also formally recognize "outstanding vendor performance" during the morning symposium by providing partnership awards to those vendors who consistently provide their Laboratory customers with outstanding service throughout the year.

Genesis: Enterprise Integration Engineering-Procurement



Future Development:

LLNL Engineering and Administrative Information Systems (AIS) are developing a pilot CITIS-like (ref 14) (Contractor Integrated Technical Information Service) web-based document server to support Engineering development and procurements called LIAM (Livermore Information and Methods) LIAM builds upon experience gained from "zephyr_partners" secure file exchange with contractors, partners and vendors

A major goal of the LIAM Project is to provide "need to know" control and access on an individual or group level to paperless documents such as electronic drawings, CAD files and models during the design phase of Engineering projects Activities include check in/out provisions with file management features, document distribution to local and remote plotters/printers, retrieve/view/transfer of CAD data (2D and 3D), collaboration, forms, search of metadata, access to translators, and review and markup (in a future phase of the pilot)

LIAM will contain web links and access to actual CAD drawings, documents on the topics of Engineering Standards, Engineering Specifications, Vendor Resources, Training Opportunities, Laboratory Resources, Bulletins and critical software applications

Information will be collected from various resources to complete the content of the pilot system Documents will be stored in a document management system operated by AIS and will provide upload, download, access control, and revision control for the documents

In the future, upon approval and release for procurement, LIAM Documents will be electronically attached to blanket order or bid-quote procurements using a web-based workflow model using lessons learned from Zephyr's pilot procurement project (fig 7)

DOE Complex

The DOE Nuclear Weapons Complex (NWC), with LLNL participation, is developing new strategies for operations that automate traditional engineering and business processes in a classified working environment, while significantly reducing cycle time and costs

DOE's Public Key Infrastructure (PKI) Working Group will orchestrate a PKI solution that spans five DOE sites This solution will enable secure, authenticated exchange of e-mail, technical data, electronic forms, and other information required to conduct complex engineering and business processes over the Internet.

It is anticipated that PKI work, developed within the Nuclear Weapons complex, will "spin-off" into unclassified engineering projects allowing commercial businesses to take advantage of this technology (ref 11)

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Approved for public release, distribution is
unlimited

Acknowledgments:

The authors wish to thank Kim Bumanlag for
her assistance with this paper, Dave Seibel
for support and development in AIS, Mitch
Neto for sponsoring code development, Ken
Luu and Ray Gonfiotti for Zephyr's pilot
within Electronics Engineering, Lee Neely
and Lynette Kessler for "Webmastering", S
Hawkins for demonstrating solid modeling
collaborative exchanges between LLNL and
Physics International, Hugh Kirbie and
Craig Ollis for collaboration of baseline
designs for the ARM Project between
Lawrence Livermore National Laboratory,
Bechtel North Las Vegas, Nevada and Allied-
Signal's Kansas City Plant, Debbie O'Dell
(ORNL) for information about SMS, L
Gottlieb, L Reed, and LLNL's Technical
Information Department for communications
support (e g graphic design, content)

This work was performed under the auspices
of the U S Department of Energy by
Lawrence Livermore National Laboratory
under Contract W-7405-ENG-48

A Secure Internet Process to Streamline Engineering

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**CALS Expo International & 21st Century Commerce 1998
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University of California



**Lawrence Livermore
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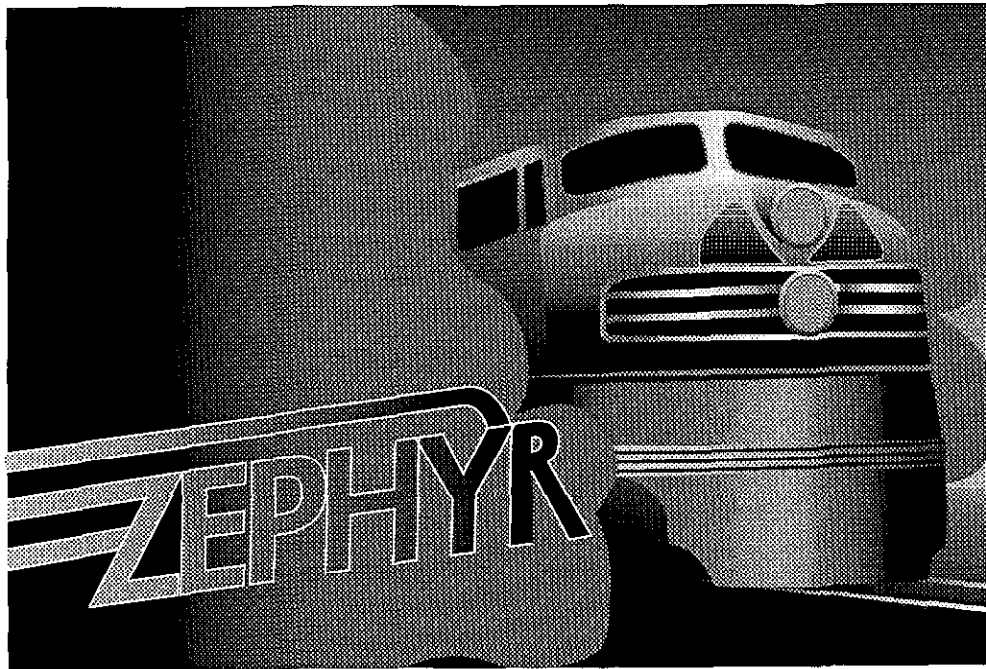


Outline: The Tracks to Enterprise Integration

- Where we've been
- Where we are
- Where we're going...

Where we've been

A Secure Internet Process to Streamline Engineering



<http://zephyr.llnl.gov/>

- Web-based Zephyr speeds procurement by 60-90%
- Secure paperless workflow enables the process
- Levels the playing field for vendors regardless of size or location

University of California

 **Lawrence Livermore
National Laboratory**

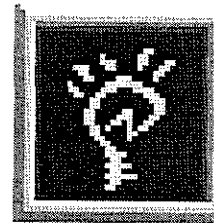
ECI 

EC History at LLNL

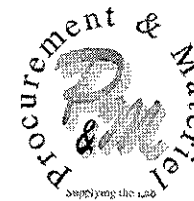
- **1991 - Logistics Information Network (LINK)**
 - Important role in Desert Storm, still in use
- **1993 - GATEC at Wright-Patterson AFB**
 - Rapid procurement of commodity items using EDI and VANs
- **1995 - LLNL/BofA Internet Bill Paying**
 - \$200M annually via the Internet, 200 vendors paid
- **1995-98 Zephyr**



Navy Best Manufacturing Practice



DOE Best Practice



Internet/Intranet Business Transactions

- **Faster, Cheaper, Smarter**
- **Elimination of Paper Cost and Delays**
- **Competitive Advantage**
 - **Fast response to customers**
 - **Rapid payment**
- **Global Commerce**
 - **No barriers to entry for remote vendors**
 - **No time zone problems**

Critical Issues in Web Commerce

- **Security**
 - Attacks on computers are probable
 - Proprietary information must be protected
 - Requires an active on-going defense
- **Administration**
 - System reliability is central to business use
- **Computer Interoperability**

Barriers to Change

- **Corporate Culture**
 - Is the new embraced or suppressed?
- **Entrenched paper-based practices**
 - They have been approved
 - They are safe and reliable
- **Human nature**
 - Change requires effort and overcoming fear

Keys to Success

- Senior executive champion
- Key supporters in functional areas
- Person by person approach
- Effective middle management network
- Excellent business case (reduced cycle-times)
- Working pilot system generating metrics
- A strong business driver

Case Study: Zephyr Pilot Rapid Procurement System

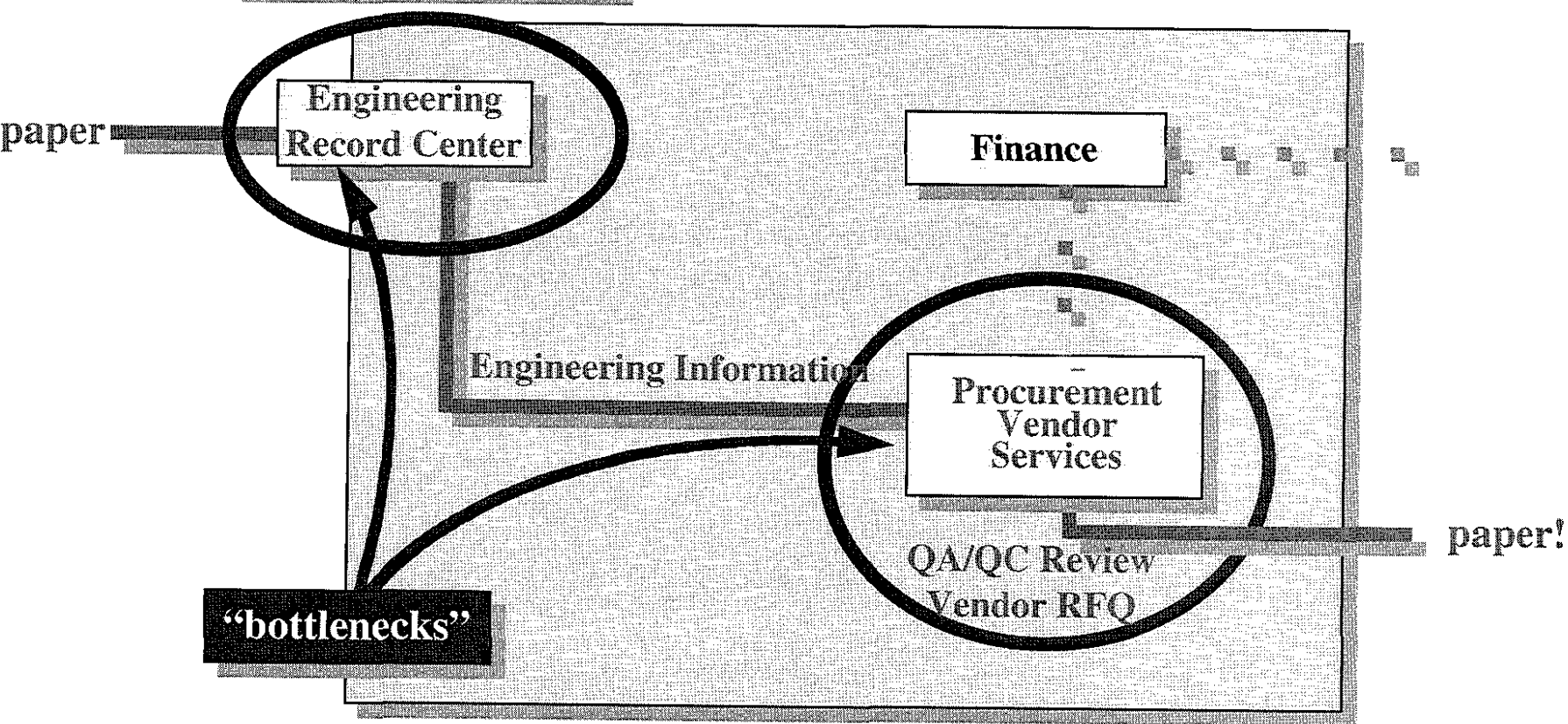
- **Driven by business need (shorten procurement time)**
- **Newly available technology**
- **Visionary leader with a mission**
- **Pressure to out-source fabrications**



Where we've been

The problems

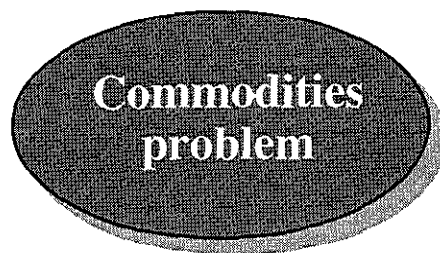
Our traditional deliverables path contained “bottlenecks” and was a maze of paper delays



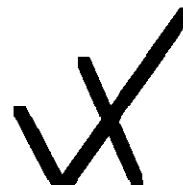
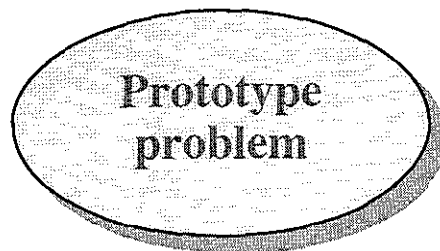
Includes major time-consuming paper-based steps

More problems

The acquisition process for prototypes was costly and had too long a cycle time



Was solved by traditional
blanket orders



Traditional blanket orders
don't solve unique article
procurements

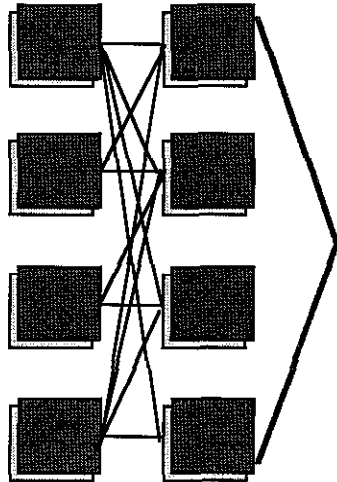
Where we've been



Solution Concept

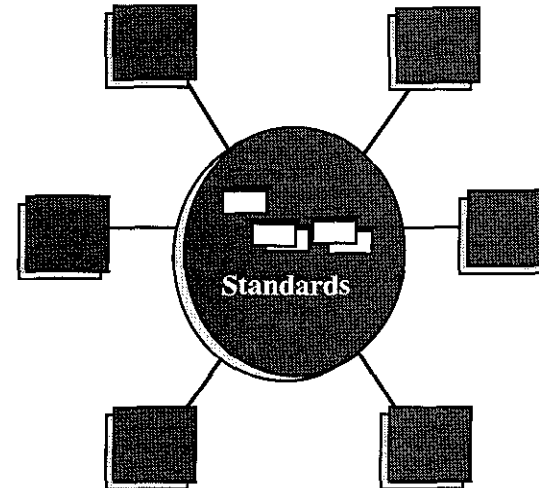
From Islands of Automation to Interoperable Systems

Islands of automation
paper flow



Transition Path

Interoperable systems
communicating Information



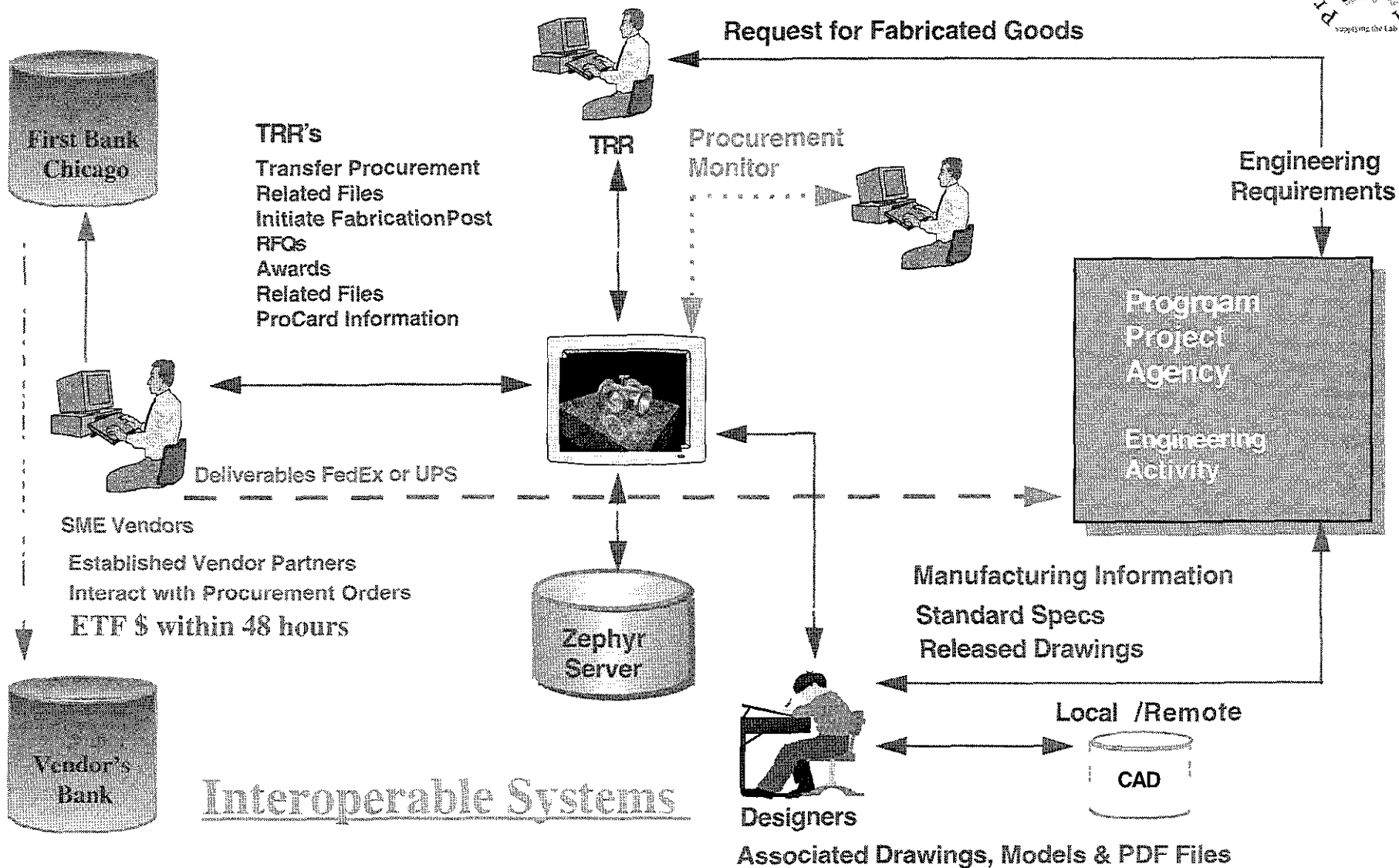
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Where we are

Model: Web-Workflow Architecture

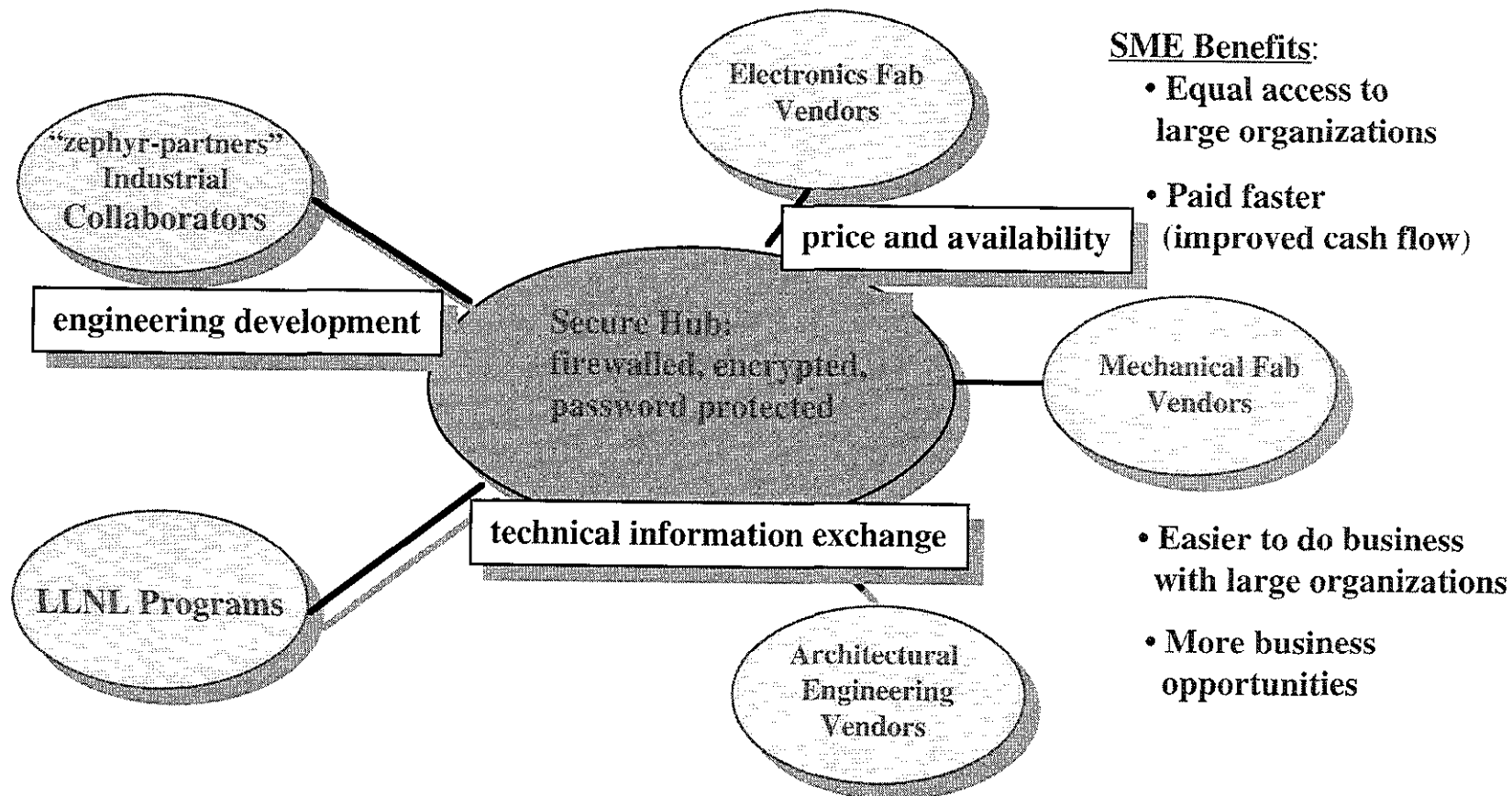


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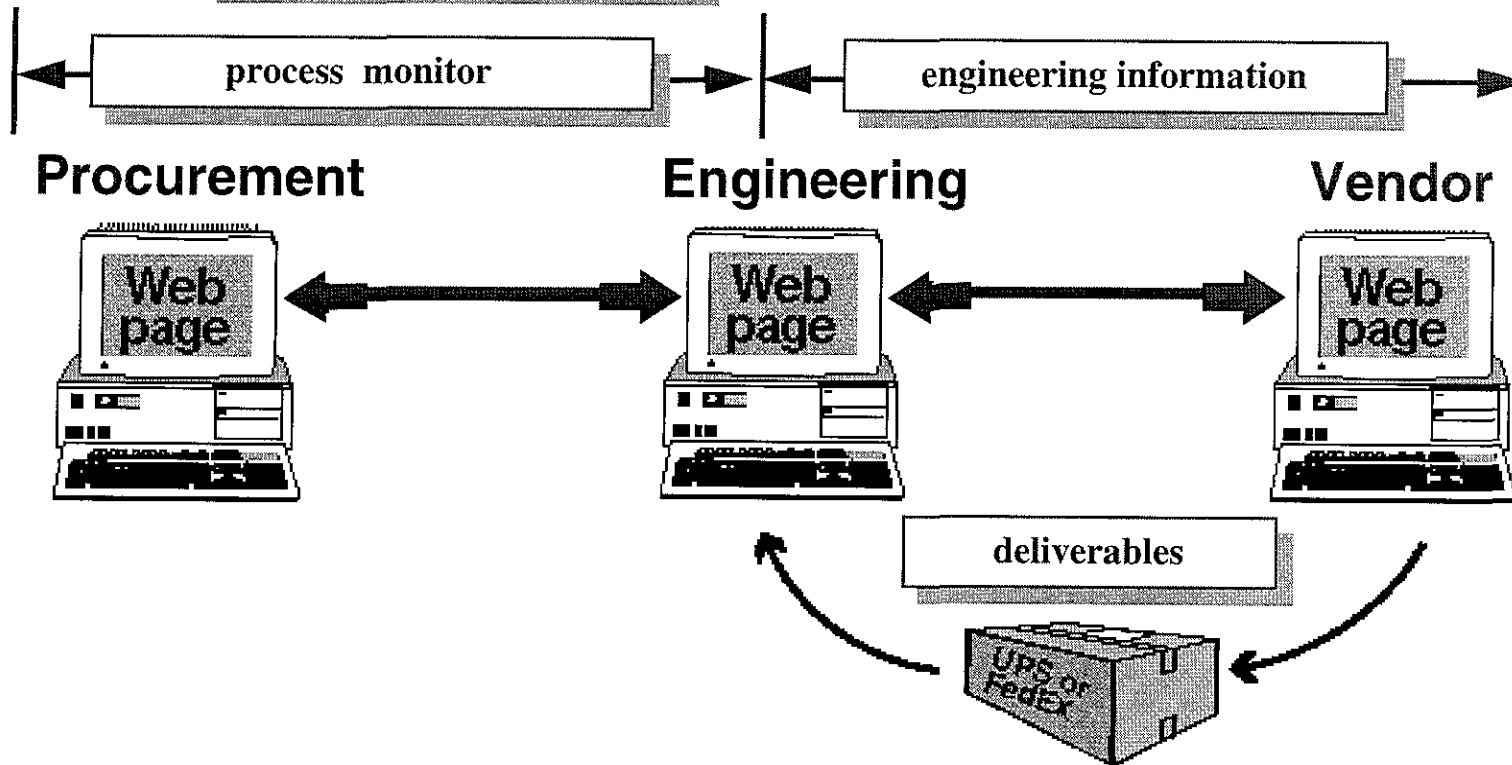
Model: Integrates LLNL, Collaborators, and Vendors



Where we are

Solution Result

Zephyr's Web-based workflow process eliminates procurement paper delays



Deliverables 60-90% Faster

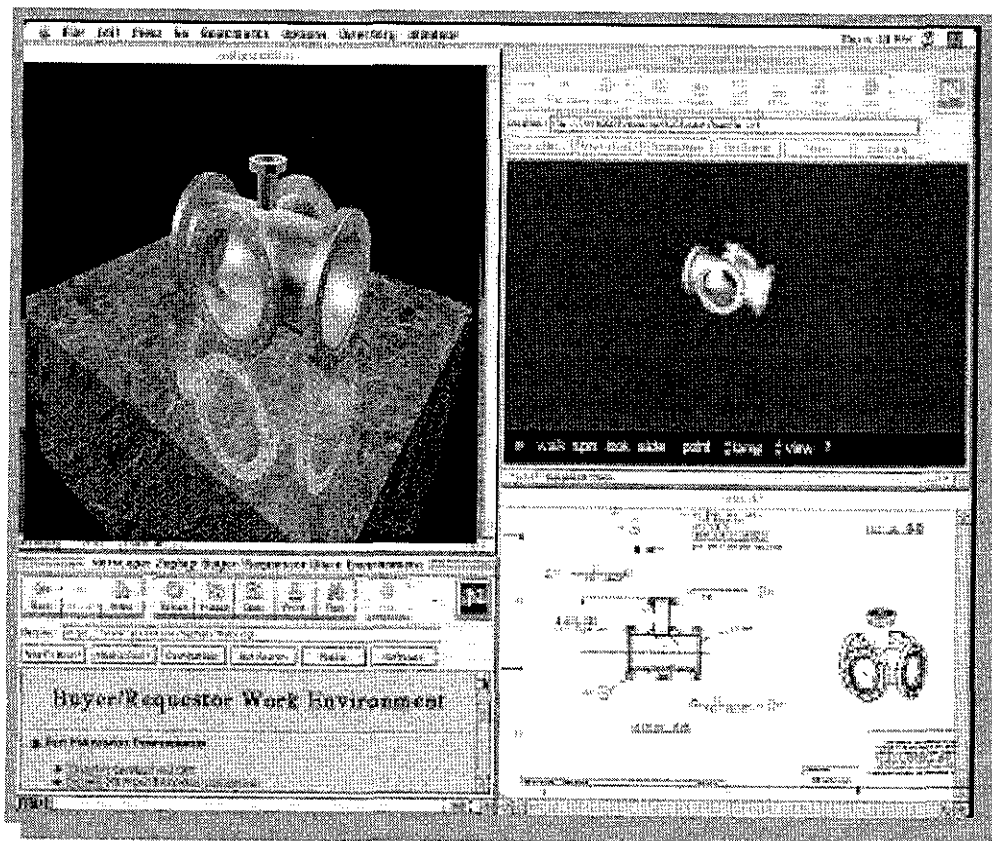
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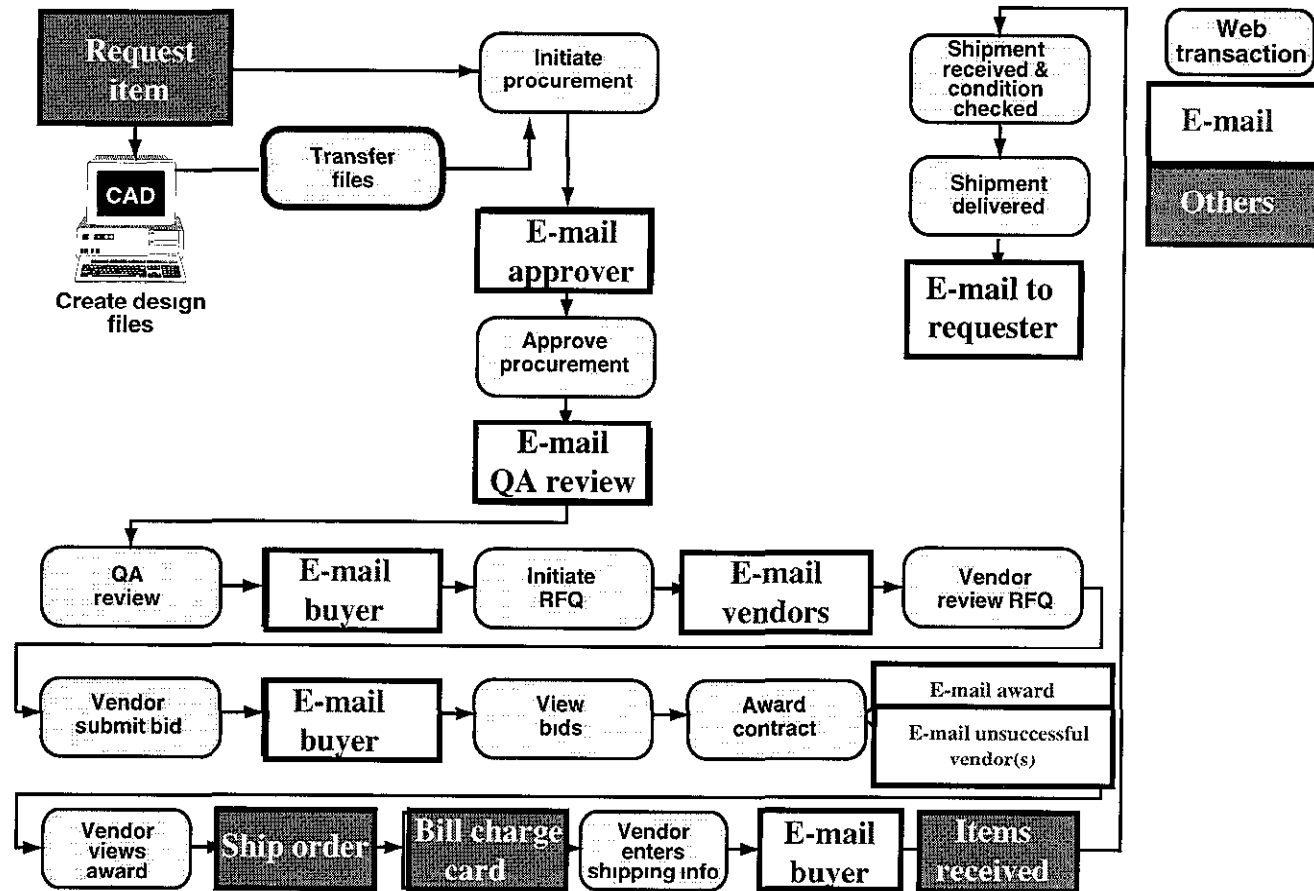
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Examples: Paperless Engineering Information



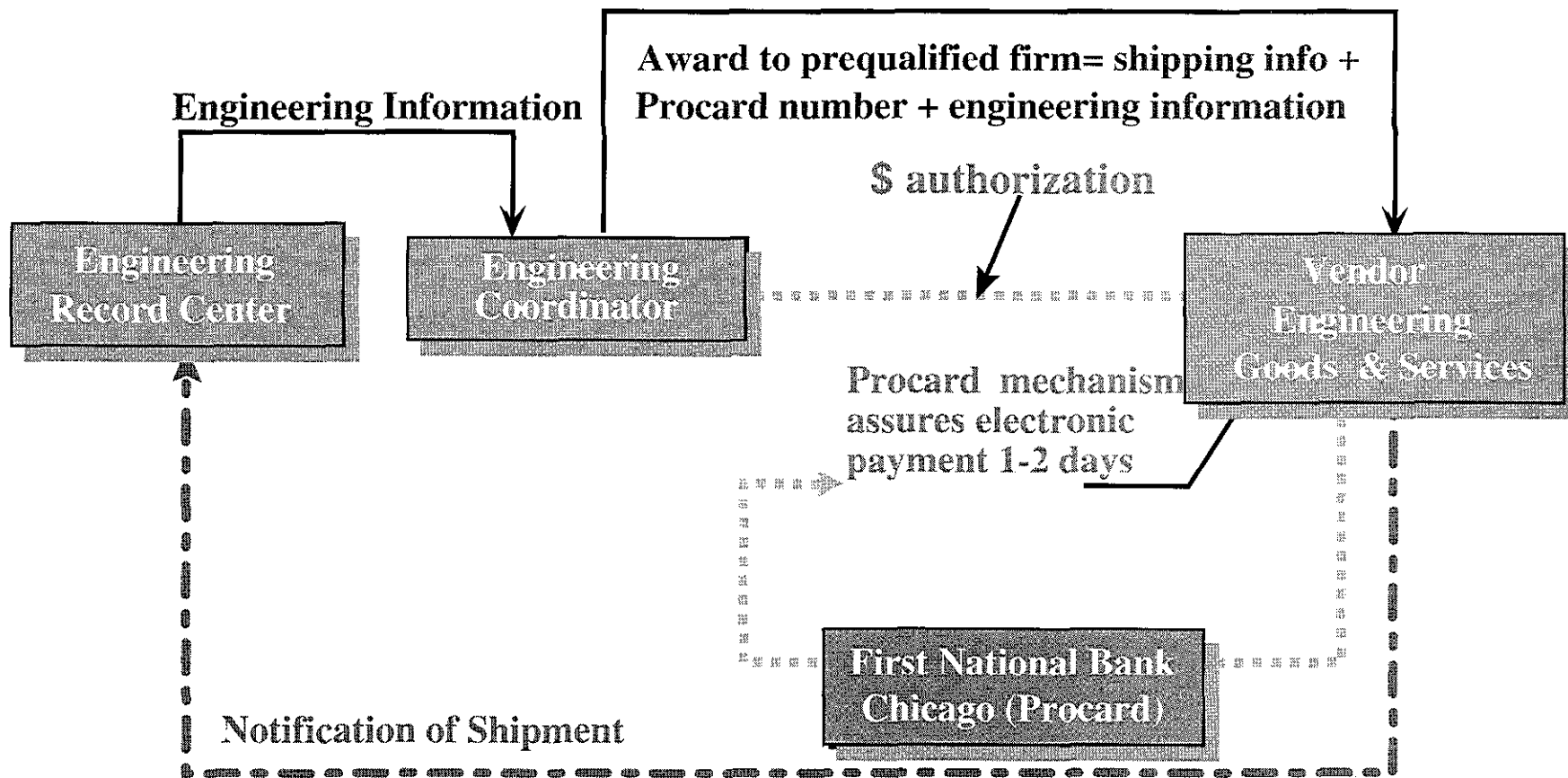
- Computer Aided Design
 - _3D solid models
 - _2D plots or “drawings”
 - _Virtual reality “views”
 - _Model-based “animation's”
- Manufacturing files
 - _CNC instructions
 - _StereoLithography
 - _Photo-tooling “gerber plots”
- MicroSoft Office Applications
 - _Word
 - _Excel
 - _PowerPoint
- Object-oriented design tools
 - _Spice
 - _MicroCap

Model: Web-based “transactions and e-mail”

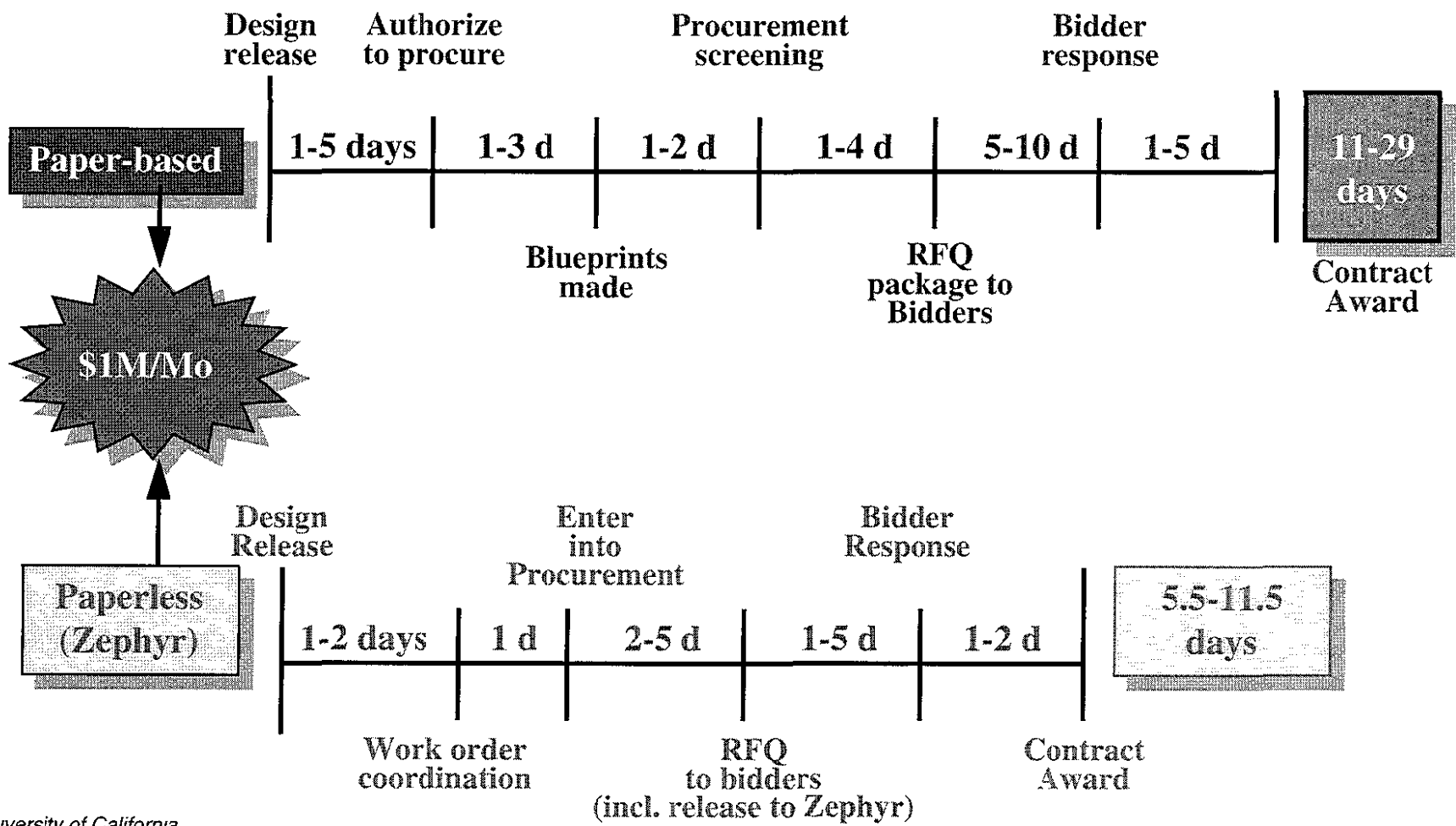


Paperless process

Engineering and Procurement provide the electronic way to eliminate paper steps

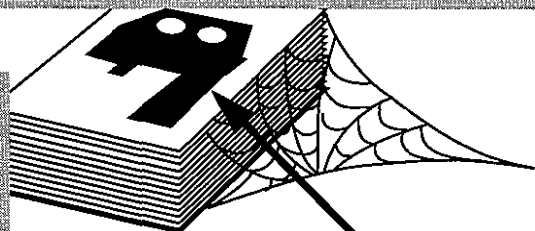


The “design release-through-contract award” cycle can be substantially cut using Web-based workflow



An actual example shows dramatic time savings

Traditional
example
(paper)

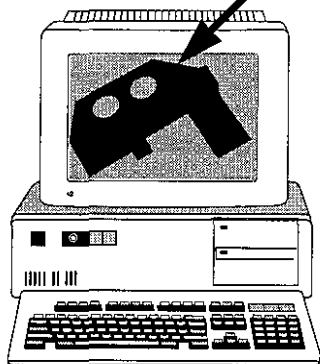


Delivered assembly fixture
for Heavy-Ion Fusion Program
(July 1995)

56 days

< \$5K procurements

Zephyr
example
(paperless)



Delivered
same
assembly
(August 1995)

5.5 days

90% time
reduction

“SMEs deliver the results”

Where we're going...



Enterprise Integration

Where we're going...



Agents of Change

- Participants
 - Administrative Information Systems
 - Computations
 - Engineering/Engineering Records Center
 - Procurement & Materiel/Information Management Division
 - Laboratory Site/Plant Engineering & Construction
 - Laser Programs/NIF
 - Technical Information Department

Working Group - Objectives

- Determine Abstract Requirements
- Define Document Management Architecture
- Research Solutions
- Learn From Pilots
- Report Findings
- Develop Institutional Document Management Strategy

Collaborative Engineering Pilot Objective

- Implement a secure project-based repository to support engineering design and archiving for use by designers and engineers from various National Laboratories, Vendors, and Contractors.

Engineering Procurement Pilot Objective

- Implement an Institutional secure paperless workflow capability for Requesters, Buyers, and On-line Vendors that supports engineering procurement Job Orders.

Common Requirements

- Provide an Institutional infrastructure that supports collaborative engineering and the procurement lifecycle
 - Change Control
 - Check In/Out
 - Automatic Revision
 - Search/Retrieve
 - Secure - 128 Bit Encryption
 - Workflow to Insure Integrity of Engineering Processes
 - Distributed Administration of Access Control
 - File Exchange of Various Engineering File Formats
 - Customizable Attributes

Where we're going...



Engineering Sources of Data

- Engineering Records Center
- Engineering Document Servers
- Product Data Management Systems
- Designers and CAD Systems

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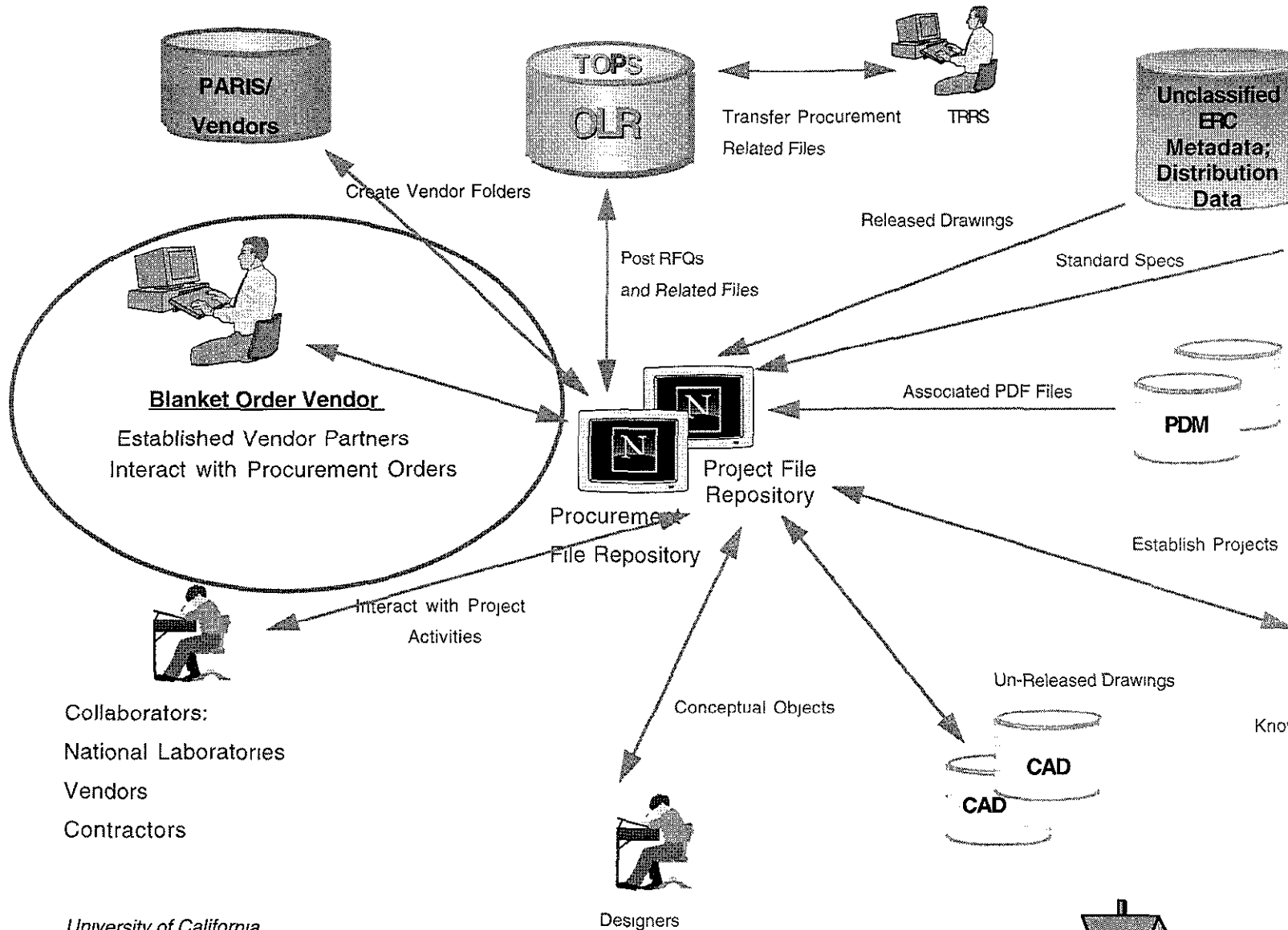
Procurement Sources of Data

- Engineering Records Center
- Technical Release Representatives
- TOPS On-line Requisition System
- PARIS (Procurement System)



Where we're going...

Model: Procurement Architecture



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Where we're going...



Model: Collaborative Engineering Architecture

Exchange:

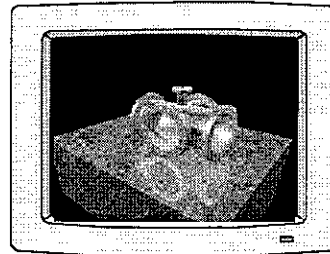
ProE Models
AutoCad Models
Common Libraries

Collaboration Space

Intelligent Objects Manufacturing Files
Test Results Photo Tooling
Spice Models LabView Programs

Features

Institution Firewall
Operations 24 x 7
Real Time Raid Backup
Code Configuration Mgt.
Web Only Client
Web Workflow
Integration Bus. Systems
Encryption 128 bit
Need to Know Access
File Access Granularity



Common Project Repository



Collaborators:
National Laboratories
Contractors
Vendors



LLNL Designers
Conceptual Objects

Unreleased Drawings



Knowledge Workers
Establish Projects

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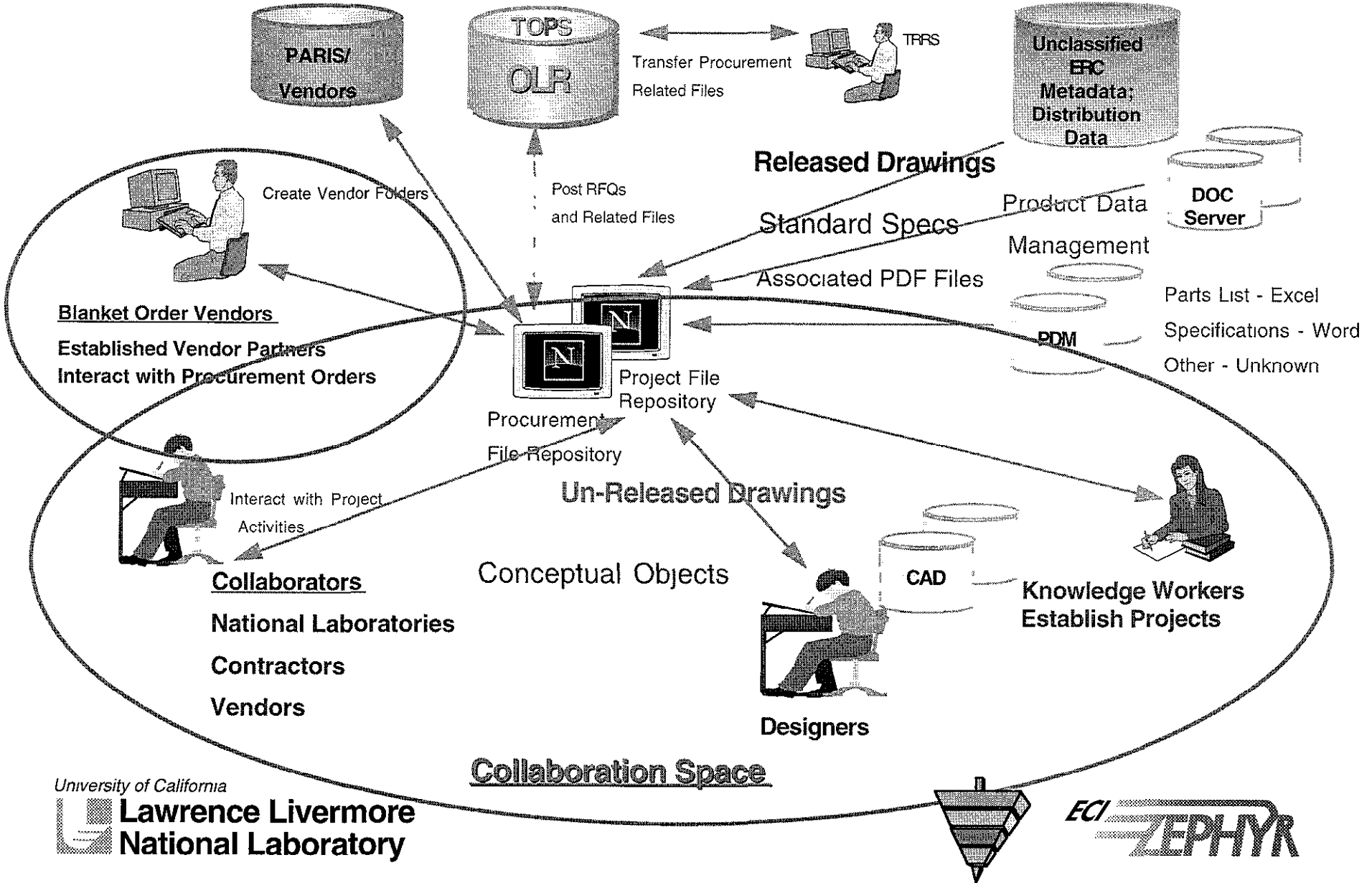


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ZEPHYR

Where we're going...



Model: Integrated Engineering-Procurement



National Ignition Facility - \$1.2B Project Uses EC for Supply Chain

- Most procurements will come from about 80 suppliers
- Organized by commodity and capacity
 - Small, Medium to Large, Mammoth
 - Vacuum equipment, plating and polishing, sheet metal, electronics, optics, etc.
- Procurement via Blanket Orders from Prequalified Firms
 - Each required to have Internet access, plotter, willing to use LLNL computers
- Approximately 2200 procurements less than \$100K each
- Expect a cost savings of \$5.5M in processing overhead alone
- Time savings critical for project success